"NEW ROADS ARE NOT ENOUGH": PLANNING AND DELIVERING MORE INTEGRATED, INTELLIGENT AND SUSTAINABLE RURAL ACCESS SYSTEMS

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ABSTRACT

There are formidable transport and related logistical difficulties with rural social service delivery, as well as the production and marketing of foodstuffs, other agriculturally based products, construction materials, etc. Many of these have to do with the large distances that have to be traversed (mostly involving the use of poor roads or tracks), relatively low densities and economies of scale, low rates of private vehicular mobility and tele-connectivity, and under-developed market facilities, storage and other logistical infrastructure. Related to this is the issue of poor rural spatial planning and coordination of service delivery, as well as the sustainability of the rural transport infrastructure.

Thus, "(new) roads are not enough" – a statement first coined by Dawson and Barwell (1993), as part of an argument in favour of a more integrated approach to rural transport planning, cannot be overemphasized.

This paper examines approaches to integrated, intelligent and sustainable rural access systems, and sets an agenda for further action and research. It further explores issues around greater connectivity, broadening the focus to include the harnessing of ICT for all the core rural *access* networks, shared spatial intelligence, and transport exchange networks as high-leverage interventions. It is suggested that ICT, tailored to address rural accessibility issues, has the ability to coordinate, synchronise or simply improve the general scheduling of rural infrastructure and service delivery operations. It is further suggested that, as in the case of rural transport networks and telecommunication networks, the potential value of enhanced spatial intelligence will only be realised if there are mutually-supporting investments and good maintenance of all the core infrastructures comprising an integrated rural access system.

1. TYPICAL RURAL SERVICE DELIVERY AND DEVELOPMENT CONTEXT

There are formidable transport and related logistical difficulties with rural social service delivery, as well as with the production and marketing of foodstuffs, other agriculturally based products, construction materials, etc.

Many of these have to do with the following factors:
- The large distances that have to be traversed, mostly involving the use of poor roads or tracks;
- Relatively low densities and economies of scale;
- Low rates of private vehicular mobility and tele-connectivity;
- Under-developed market facilities, storage and other logistical infrastructure.

A related set of factors has to do with poor rural spatial planning and coordination of service delivery. At the broad district or wider regional level, the spatial hierarchy of major and minor towns is relatively well developed, as is the network of national and provincial trunk roads connecting them. But beyond that, there is typically very little obvious differentiation in the centrality or hierarchical status of different villages. A consequence of this is the apparently haphazard dispersal of social and business facilities among these villages, and the relatively "big jump" from the village (and its ubiquitous store or local school) to the nearest town centre (Mashiri, et al., 2002).

Another key concern is the sustainability of the rural transport infrastructure. Without timeous and sufficient expenditure on its maintenance and rehabilitation, the requirements are predicted to escalate to such a degree that all, or most, future spending might – by default – be absorbed by the need to rehabilitate or reconstruct. This will then leave very little for any of the other rural accessibility priorities.

Seen in terms of this context, "(new) roads are not enough". This statement was first coined by Dawson and Barwell (1993), as part of an argument in favour of a more integrated approach to rural transport planning.

2. GREATER INTEGRATION: SOUTH AFRICAN & INTERNATIONAL APPROACHES

In South Africa, the term *integration* is usually interpreted to mean that there should be more *integrated planning.* Integrated *development* planning (IDP) is envisaged to provide the overall guiding framework, in terms of which other integrated plans – such as spatial development frameworks (SDFs) and integrated transport plans (ITPs) – are produced.

In theory, both the process and the results of integrated planning should be "integrated". In terms of process, it usually means that there should be an inclusive assessment of different intervention options in terms of overall development goals. With regard to results, it usually means that there should be a balanced portfolio of mutually supporting service delivery and other interventions.

Internationally, the closest equivalent to IDP and Integrated Transport Planning is the IRAP methodology, which stands for *Integrated Rural Access Planning*. As implied by the name, it has a specific rural focus, and improved *accessibility* is seen as the relevant development goal to be achieved.

This approach is sometimes also referred to as *accessibility planning,* defined as follows (Tighe, 2000):

Accessibility planning sets out to capture, through questioning and analysis, the particular pattern of isolation of a community and hence derives a hierarchy of actions to be taken to reduce it. Road improvements are a possibility, but so also are improvements of tracks and footpaths, propagation of intermediate means of transport (IMT), measures to improve conventional transport services, and relocation of social and economic services. Measures are prioritised by their cost-effectiveness relative to indices of accessibility, preferably set nationally to ensure equity among regions.

In contrast to the supply-oriented focus of Integrated Transport Planning (as currently practiced in South Africa), the IRAP methodology takes the community and its access needs as the point of departure, and considers transport as well as non-transport intervention options (as outlined above).

The typical bottom-up, needs-focussed IRAP process is, however, very time consuming and resource-intensive. Another shortcoming of the current IRAP approach (such as promoted by the International Labour Organisation) is that it provides very little guidance on the use of communications and related digital technologies to achieve greater integration and delivery efficiency.

3. GREATER CONNECTIVITY AND INFORMATION COMMUNICATION TECHNOLOGIES (ICT)-BASED INTELLIGENCE

It is well known that telecommunications access (connectivity) contributes positively and significantly to rural social networking and economic growth, but that this is dependent on also having roads, electricity and other elements of economic infrastructure in place (Caspary and O'Connor, 2003). What is less well known or appreciated is the extent to which the rural development impacts of telecommunications access can also be enhanced through other ICT-related infrastructures such as the following:

Improved *spatial data infrastructure*, GPS and other spatial referencing technologies;
* *The internet and the associated computing and search engine infrastructure;*
* *The emerging sensor and related computing infrastructure* – sometimes referred to as the Sensor Web.

By effectively deploying these infrastructures together with the basic tele-conectivity infrastructure in the rural transport field, it is not inconceivable that one could see the emergence of various rural ITS offerings. As noted by the Rural ITS free press (2000):

Intelligent Transportation Systems (ITS) applies advanced communication, information and electronics technology to solve existing transportation problems. Collectively, a broad range of diverse technologies are known as ITS. In its simplest form, ITS is [based on improved] data and information sharing.

4. INTELLIGENT RURAL TRANSPORT SYSTEMS OR INTELLIGENT RURAL ACCESS SYSTEMS?

Given that *transportation problems* are often only manifestations of more fundamental *accessibility problems*, the question arises whether a focus on rural ITS is perhaps not too narrow, and whether the focus should thus be broadened to include the harnessing of ICT for all the core rural access networks?[1]

Besides *transport* and *telecommunications* networks, one may define two other sets of "core rural access networks". The first is the *hierarchy of central places or service centres*, comprising small or periodic service points in low density areas, and higher-order, more specialised centres in central locations and/or high demand areas.

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[1]Another question to which we shall return later, is whether any of this is affordable and feasible in typical rural contexts – especially rural 'second economy' contexts.

The second is the *trust and local-knowledge based social exchange networks*[2] that have traditionally occurred mainly in terms of localised face-to-face interactions, and were restricted to the transfer of tacit or partly-codified "head knowledge", as well as other non-monetary exchanges. With the expansion of modern communications and information technologies as well as commercial governance mechanisms, this is no longer true, since the range of relationships and regular interactions have now extended to wider, more formalised networks involving monetary exchange, digital codification of knowledge and the use of formal *creditworthiness* inclusion criteria (in addition to experience-based or informal *trustworthiness* criteria).

A good example is how, as part of the world-renowned Grameen development initiative, the trust-based social networks of rural Bangladeshi women were extended and transformed into micro-finance and mobile phone hiring networks[3], based on the maintenance of formally monitored creditworthiness (Aminuzzaman et al, 2002).

The transformed network is thus possibly best perceived as a *local exchange network* embedded in, or linked to a *wide-area exchange network,* and possessing different types of "intelligence" (such as intelligence about the credit/ trustworthiness of people and enterprises, as well as intelligence about who is *needing* what, and *providing* what, where and when).

5. MODEL OF AN INTEGRATED AND INTELLIGENT RURAL ACCESS SYSTEM

Against this background, Figure 1 sets out a conceptual model of five inter-related access-providing networks, working together to provide an integrated and intelligent rural access system.
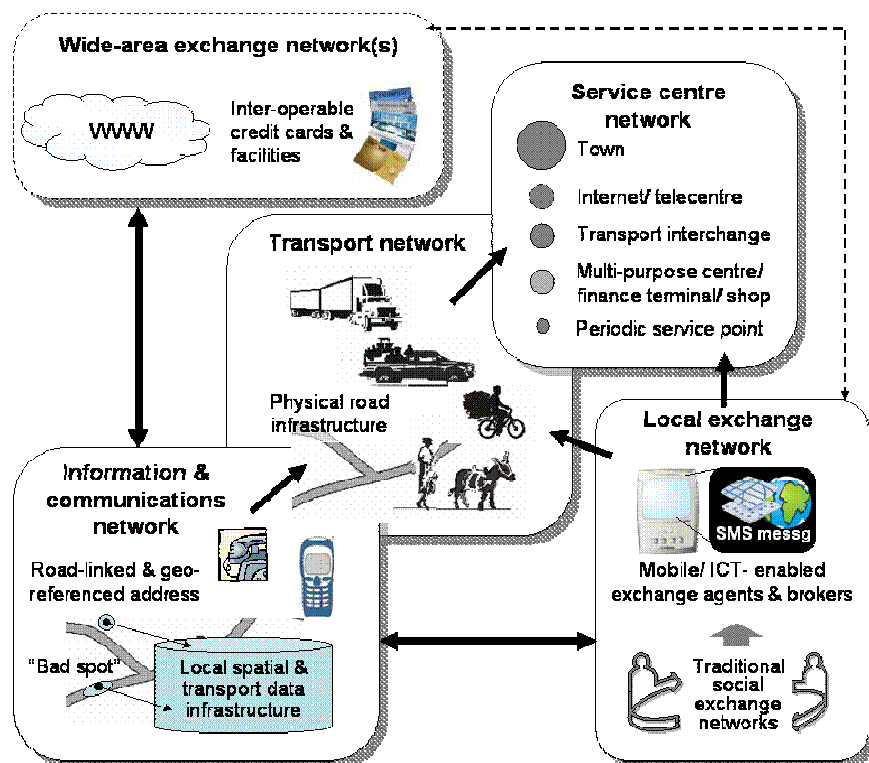

Figure 1. Key components of an integrated and intelligent rural access system.

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[2]These networks are now often referred to as a community or society's *social capital*.
[3]The operator charges the market retail rate, while Grameen Telecom charges her half that rate for buying bulk airtime.

Based on this diagram, it is possible to discern that a rural area's information and communication network could have both a *direct* influence on the area's transport network (e.g. by making it more intelligible), as well as an *indirect* influence. The latter refers particularly to the impacts of ICT on the establishment of enhanced exchange networks, which in turn, could have positive impacts on transport-related exchanges (such as logistics brokering).

6. EXAMPLE OF THE SYSTEM'S POSSIBLE FUNCTIONING AND EVOLUTION

To conceptualise the operation of such a system, let us assume a particular rural community has a couple of agents (women, for argument's sake) who are part of a Grameen-type network with access to micro-finance, and who are now also renting out mobile phones and engaging in transport/logistics brokering. Let us also assume that some of their clients have basic mobile phones, whilst the agents have at least two or three of the latest generation phones or laptop hybrids (with web-mapping, GPS, camera, credit, data storage and LBS-procurement facilities).

Using their advanced phones, they could scan information on market prices at the nearest town or city (or subscribe to a market information service), send this via *sms* to local agricultural enterprises, and organise freight transport for them. They could also obtain credit for part-payment of the producers, and use some of this to pay the transport operators. But, as is the case in many 'second economy' rural areas, the volume of produce is likely to be too low or too erratic for regularly making up full loads for a large truck or container. In most cases – especially involving low valued goods such as maize and vegetables – using LDVs or smaller trucks would be too expensive. It is also likely that mainstream transport operators would put a high premium on going into areas where they might get lost, or where roads are periodically impassable. To reduce the overall level of uncertainty (and thus increase the shared intelligence about what is where, including road conditions), it might be possible to obtain donor funding or government grants for extending and/or updating the *local spatial and transport data infrastructure* (see Figure 2).

Funded in this way, the agents could then lease their advanced phones and contract other, *information gathering agents.* These contracted agents would be tasked with regularly travelling the local roads, taking and transmitting geo-referenced photos of any "bad spots", as well as any progress that might have been made with fixing these. (Figure 2 shows how such a system could facilitate the dispatching of mobile public works teams and provide support to transport and equipment providers).

At the same time, these information gathering agents could capture information on enterprise locations, crop conditions and relevant service providers (i.e. the location of LDV or small truck owners). This information could then be combined with other remotely captured or existing spatial and transport information, both in terms of geo-coordinates and in terms of positions relative to identified "markers" along the local road network[4].

By using this information, market or logistic brokering agents could become much more certain and pro-active about the organisation of regular, fully loaded market deliveries and/or inter-modal interchanges (from small to higher capacity trucks or rail cars), and thus generate demand-pull incentives for higher levels of agricultural production. Figure 3 gives an example of a mapping and decision support interface that could be developed to assist

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[4]As part of a recent project for Eskom, the firm GeoSpace developed an address allocation and spatial referencing system for rural dwellings that is based on measurements along the road network as well as geo-coordinates.

with the calculation of potential shipment volumes, the location of transhipment centres, and the routing and scheduling of bulk freight transport services.
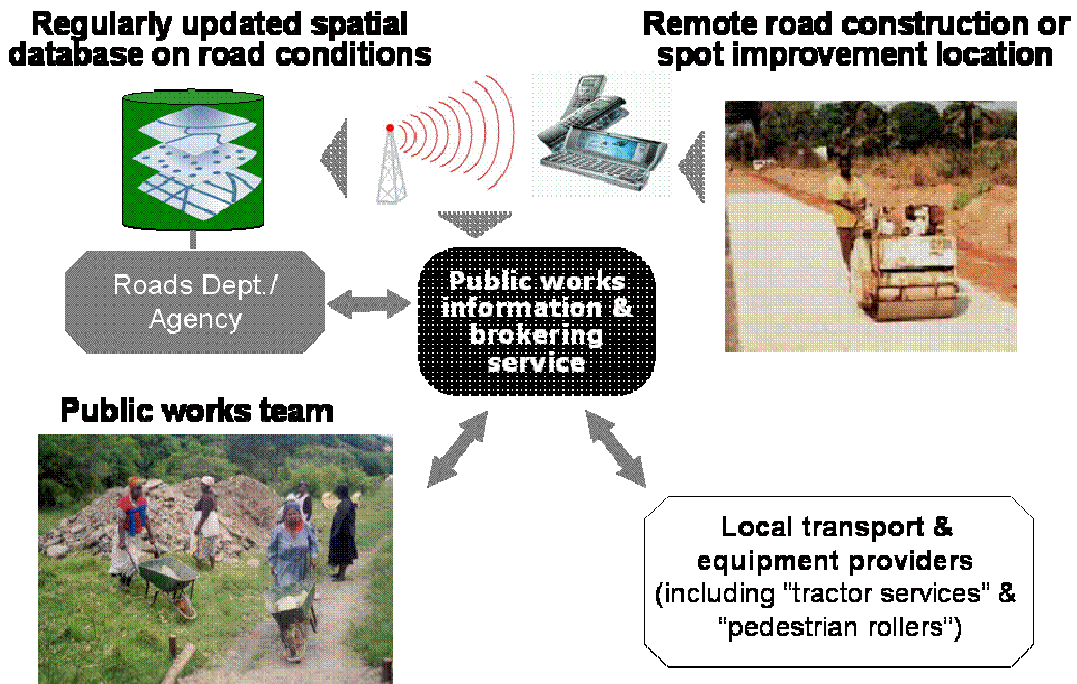

Figure 2. Spatially intelligent system for recording spot improvement locations and organising mobile public works operations.
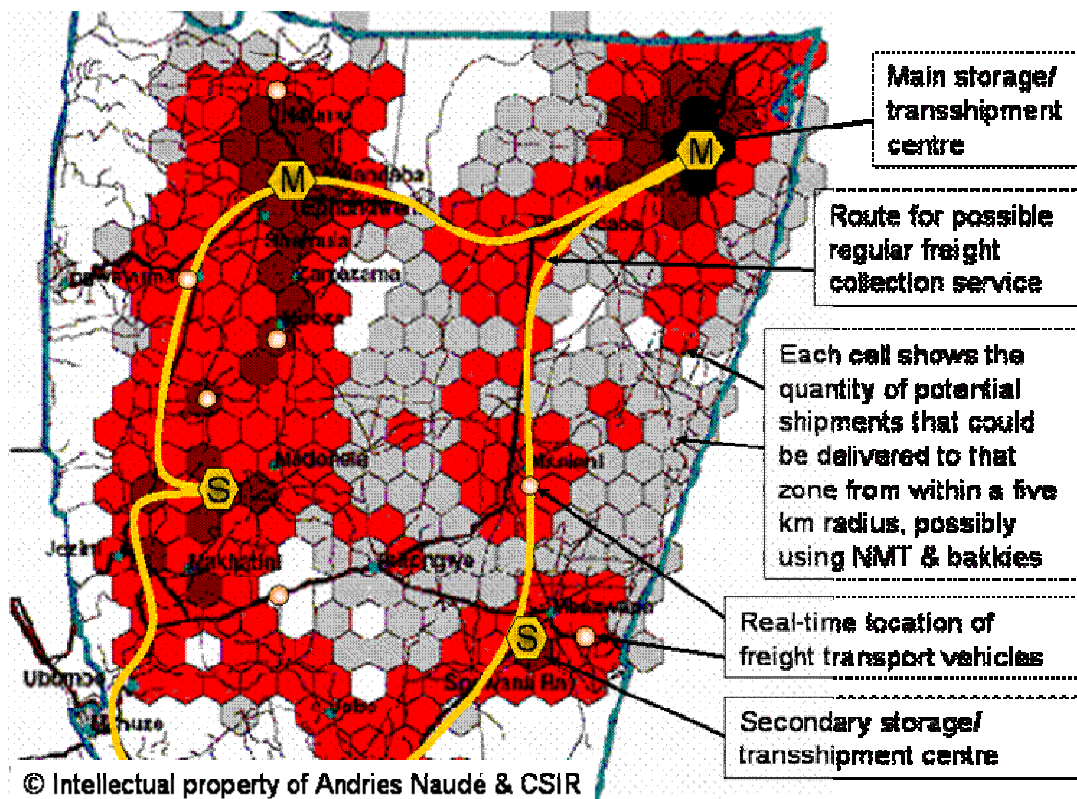

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Figure 3. Mock-up of a just-in-time map that could be produced as part of a location-based logistics planning and coordination system.

7. VALUE OF HAVING AND SHARING DYNAMIC SPATIAL INTELLIGENCE

One of the most important insights of the preceding narrative – and the capabilities illustrated by Figures 2 and 3 – is the value of having and being able to share "dynamic spatial intelligence". This notion of intelligence is briefly defined in the box below.

> *Dynamic spatial intelligence* – alternatively *spatial and temporal intelligence* – can be defined as regularly updated, synoptic knowledge about the locations, spatial contexts, spatial relationships and "chaining" of static as well as mobile objects, agents and activities. "Chaining" can, in turn, be defined as the sequencing, routing and linking of objects, agents and activities undertaken as part of a *purposeful human endeavour* (ranging in complexity from a single-person trip from point A to point B, to the orchestration and operation of a complex product and information supply chain). As a result of: a) limited data storage and transfer capabilities; b) the wide range and sheer volume of "chained" human endeavours; c) privacy rights and concerns; d) economic competitiveness issues; and, d) socio-cultural taboos, exchange norms and power relationships; dynamic spatial intelligence will always be only partially or selectively shared. However, because of the dramatic impacts of ongoing advances in communication, information and geomatics technologies on data handling and related constraints, society is likely to experience a succession of quantum jumps in the volume and/or quality of *shared spatial and temporal intelligence*.

The typical rural road agency or transport/logistics broker need not understand any of this (at least not at an abstract level), but enabled by the embedded capabilities of the latest and future generation cell-phones, PDAs and other devices, their increasing ability to use and share dynamic spatial intelligence can bring many benefits. Examples of some of the rural applications and associated benefits were discussed above.

These can be summarised and extended as follows:
- Regular transmission of geo-referenced information (including photos) of newly formed potholes and other bad spots on roads, followed by the commissioning and dispatching of mobile public works teams and supporting transport and equipment providers (see Figure 2);
- Vastly improved health logistics and general coordination of the services provided by hospitals, clinics, mobile clinics, and home-care health workers;
- Enhanced general abilities to locate and convey needs for government services, as well as improve the accessibility, responsiveness, speed and quality of these services;
- Vastly improved abilities to consolidate low supply chain volumes (combine part loads into full loads), use more cost-efficient freight transport modes and organise just-in-time modal transfers (see Figure 3);
- Improved coordination of various periodic activities, such as periodic markets, visits by mobile clinics and traders, and improved support to transport and logistical services.

8. IMPORTANT PROVISOS AND IMPLICATIONS FOR GOVERNMENT

As in the case of rural transport networks and telecom networks, the potential value of enhanced spatial intelligence will only be realised if there are mutually-supporting investments and good maintenance of all the core infrastructures comprising an integrated rural access system.

Besides roads and communications infrastructure, this should be seen to include:
- Transport and spatial data infrastructure; and,
- Dedicated and multi-purpose facilities.

Although a large proportion of telecentres, Multi-purpose Community Centres (MPCCs) and similar facilities cost too much in terms of capital for the services they deliver, have great difficulty in covering running costs, and can only be sustained through ongoing donor grants or government subsidies (Benjamin and Dahms, 1999, Benjamin, 2000), there is still a strong case to be made for well-managed, government-supported initiatives in this regard.

Part of the argument is that it is unrealistic to expect full cost recovery and that – similar to the practice of providing roads and other basic access infrastructure – there should be greater acknowledgement and allowance for government subsidies. The issue of whether and how to provide subsidies could be seen to also impact on the affordability of *rural transport and communications operations*. Despite technology-related reductions in overall rural access costs (such as achieving fuller loads and reducing the proportion of fruitless journeys), these costs could still be significantly above the affordability range of most rural households and enterprises.

Against this background, the implications for government include:
- A broadening and redefinition of the scope of the essential rural economic, social and data infrastructure that should be provided (or enabled) by government;
- A shift from direct government or single agency service provision models to more flexible, network or partnership-based models;
- A greater role for location-based or spatially targeted electronic grants, subsidies and other payments (e.g. subsidies paid in terms of the relative location or accessibility of citizens in relation to the nearest service point).

9. DEVELOPMENT AND IMPLEMENTATION OF SOUTH AFRICA'S RURAL TRANSPORT STRATEGY

Several of the intervention concepts and guidelines outlined in this paper have been derived from, or have influenced the development of South Africa's evolving Rural Transport Strategy (the first draft – essentially the same as the 2005 version – was released in 2002 (Mashiri et al, 2002)). Figure 5 illustrates the overall guiding concept, first developed in 1998 (Naude et al, 1998) and refined in 2001 (Buthelezi et al, 2001).

The diagram illustrates the typical South African rural context:
- A district town linked to the "economic mainstream"; and,
- A poorly connected set of villages and hinterlands with under-utilised human capital and physical resources (e.g. croplands or community forests).

To redress this situation, the Strategy highlights the need to develop *nodes* (such as MPCCs) and *linkages* (both transport and communication linkages) in a coordinated manner.
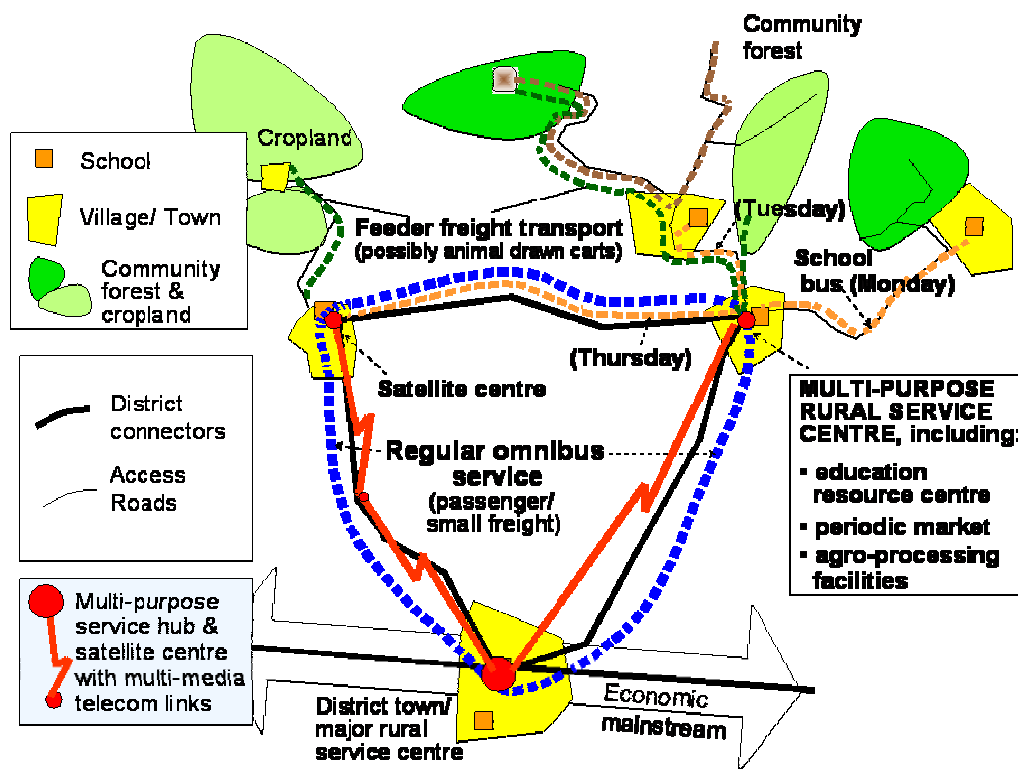
Figure 5. Original guiding concept for the rural transport strategy.

Besides investing in *district and access roads*, part of the recommended intervention package is to:

- Support the establishment of multi-purpose service hub and satellite centres; with the latter functioning also as the priority nodes for periodic markets, business or logistical support centre, upgraded schools or education resource centres, and agro-processing facilities;

- Link the MPCCs and other priority nodes with *"multi-media telecommunication links"* as well as with uniquely "rural" transport services such as the following:
  - Periodic learner transport services (i.e. a service that would bring pupils on alternate days from surrounding schools to use the centre facilities (e.g. science, IT and TV labs) and obtain specialised tuition);
  - Omnibus, or mixed passenger and freight services;
  - *Periodic public transport access services*, operating on a roving basis to transport people to and from surrounding areas for one or more days, when a periodic market, pension payout, etc. are scheduled for a particular centre;

- Facilitate the development of *transport brokering services,* and use these to establish an inter-linked range of demand-responsive rural transport services;

- Promote the use of *animal-drawn carts, bicycles and other low-technology transport solutions*, focussing particularly on remote areas with impassable road and tracks, and on the mobility needs of women, learners and other of vulnerable groups.

As part of the first implementation phase of this strategy (2005-2006 financial year), the initial strong emphasis on the role of MPCC's and other forms of "nodal development" has been somewhat reduced, partly because of it falling outside the mandate of the Department of Transport and Provincial Transport Authorities, and partly because of the absence of proven examples where MPCCs have played a significant transport or logistics coordinating role.

Figure 6 indicates four main implementation focus areas:

1. Non-motorised transport infrastructure (including paths and river crossing) and non-motorised means of transport;
2. Social transport services (including all of the periodic transport services referred to above);
3. Rural freight movements;
4. Transport brokering, operational coordination and financing mechanisms, referring both to social (passenger) transport and freight movements.
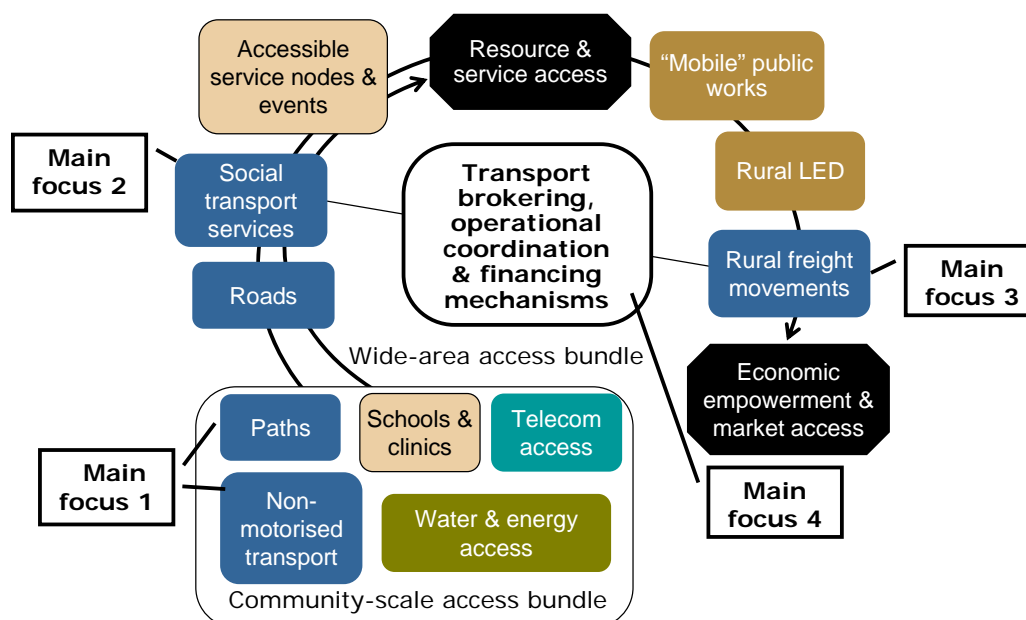

Figure 6. Rural transport strategy "intervention wheel" and focus areas.

For obvious reasons, much of the success of the strategy will depend on the last of these. Besides its potential to facilitate a greater and more affordable range of passenger, freight and omnibus transport services, the same set of mechanisms could potentially also be used to manage a system of mobile public works teams. This, in turn, could have positive spin-offs for the maintenance and general condition of the rural transport network.

10. TRANSPORT EXCHANGE NETWORKS AS HIGH-LEVERAGE INTERVENTIONS

Following on some of the earlier arguments and ideas presented in this paper, it might be possible to deploy most of the required transport brokering, operational coordination and financing mechanisms in terms of a so-called *transport exchange network[5]*.

In contrast to the MPCC-focussed brokering system which underpins the Rural Transport Strategy, this notion of a transport exchange network is not bound to any specific set of physical locations or types of centres. Whilst it could be possible and desirable that either the specialised "main centre" services or the agency services shown in Figure 7 are, indeed, located at MPCCs, this need not be the case. In fact, a large proportion of the agency services could be provided at transport interchanges, shops and filling stations. As discussed previously, home-based agents operating according to the Grameen model might also be a possibility. Finally, by using the internet (such as provided at so-called Digital Doorways) or their mobile phones (or that of agents), clients could also undertake bookings and other transport-related exchanges themselves.

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[5] In a related SATC paper based on a feasibility study of similar ideas in the Central Karoo (Green et al, 2005), this concept is referred to as a *transport brokerage*.
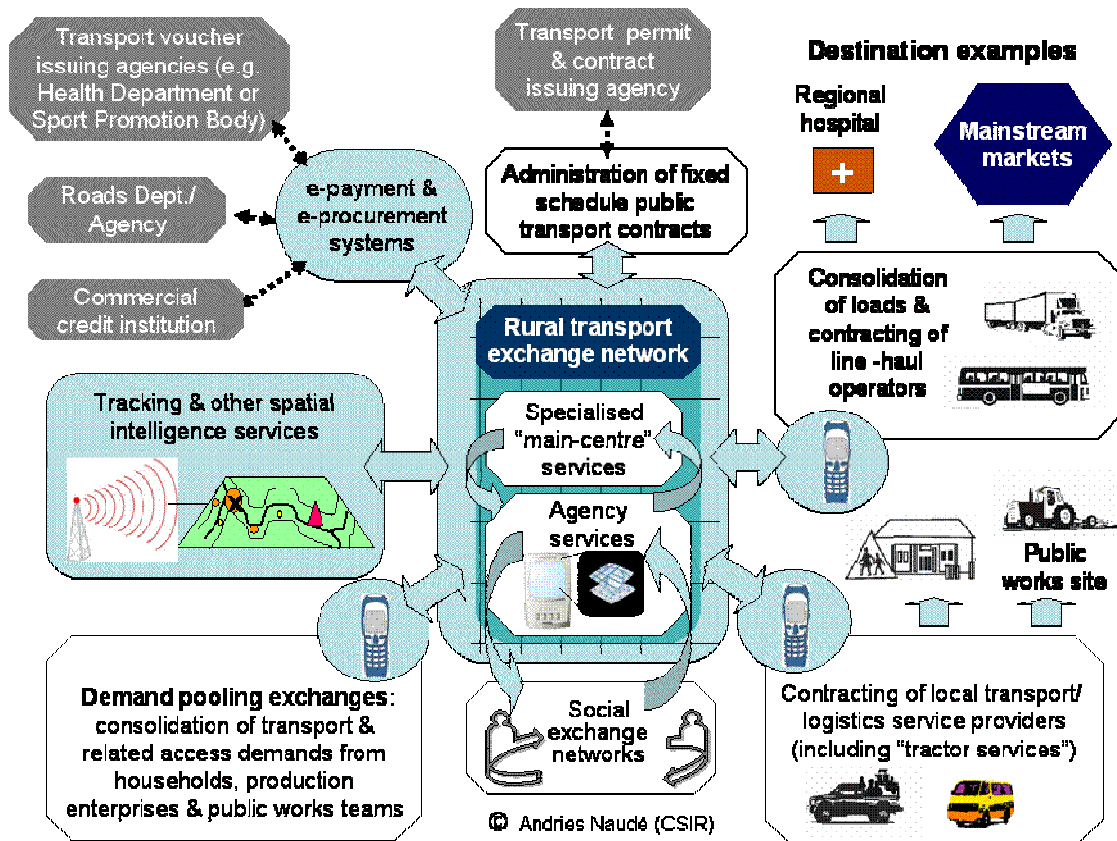
Figure 7. Diagrammatic outline of a rural transport exchange network.

Figure 7 also shows how such a system could:
- Facilitate demand-pooling exchanges;
- Assist with the contracting of local transport/logistics providers;
- Support the consolidation of loads and the contracting of high-volume, line haul operators;
- Assist with the monitoring and administration of public transport contracts;
- Administer voucher payments (e.g. a system of monthly transport voucher issued to Aids patients);
- Provide a tracking service (e.g. monitor the movement of mini-containers sent to urban markets).

In future, such a system might also provide a vehicle for issuing location-based or spatially targeted electronic grants, subsidies and other payments (as discussed under Section 8).

11. DEPLOYMENT CHALLENGES

Much of this of course depends on the ability to effectively address certain critical technological, financial and institutional deployment challenges. Many of these challenges relate to the establishment of the necessary conditions for "spatially intelligent" or "location-aware" communications and transactions.

These include:
- A certain basic level of spatial data infrastructure;
- A certain critical mass of inter-operable location-aware communication devices (such as 3G mobile phones);

- Secure and inter-operable transaction support systems;
- Viable charging mechanisms and affordable charges.

As noted earlier, it is unrealistic to expect full private-sector cost recovery, and that is therefore a need to broaden and/or redefine the scope of the essential rural infrastructure and services enabled by government.

Besides the provision of grants to improve the level of transport and spatial data infrastructure in rural areas, it can be argued that government should at least give equal consideration to the subsidisation of:
- Actual or physical transport services; and,
- Transport demand pooling, brokering and exchange services.

In contrast to urban areas, where (peak) demand volumes are such that demand pooling can simply occur through congregation and queuing at designated stops and terminals, the low and varied transport demands in rural areas provide a *prima facie* context for giving relatively more attention to the latter type of subsidy.

12. CONCLUSION

The digital or ICT revolution is bringing a whole new set of dynamics into play in terms of the accessibility conditions in rural areas. One manifestation is increasing cellphone ownership, coverage and usage – which are expected to continue expanding even among those classified as chronically poor.

In other words, there is likely to be a quantum jump in rural society, government and server providers' shared intelligence about what is needed, and who is providing what, where and when. By implication, there could then also be a quantum jump in the ability to coordinate, synchronise or simply improve the general scheduling of rural infrastructure and service delivery operations.

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